PATENT SPECIFICATION

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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Improvements in or relating to Releasable Fluid-Tight Joints

WE, SIEMENS-SCHUCKERTWERKE AKTIENGESELLSCHAFT, a German Company, of Berlin and Erlangen, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

This invention relates to releasable fluid-tight joints suitable for use in joining sections of wall separating two media, for example in a nuclear reactor, and for sealing vessels and conduits, for example the guide tubes for the fuel elements of a nuclear reactor.

Various constructions of releasable joints which are fluid-tight under pressure, for joining sections of wall or for closing containers, such as for example nuclear reactor chambers, are known. Most of such joints have the common feature that closure and fluid-tight sealing is effected from the outside, for example by means of a screwthread. Thus, it is known to employ a metal ring which is pressed resiliently against a contact surface by a conical pressure member to produce the desired sealing atcion. The ring is thus elastically deformed and may even be subjected to plastic flow. Considerable force is necessary for effecting such deformation so that the force-transmitting spindle or screw must have certain minimum dimensions. In some such joints the sealing ring is so damaged by the deformation that it can only be used once.

According to the present invention there is provided a releasable fluid-tight joint comprising co-operating first and second joint means, each joint means having a sealing portion adapted to co-operate with the sealing portion of the other joint means and remote from said sealing portion a connecting portion adapted to engage positively with the connecting portion of the other joint means, said joint means being made from materials and having dimensions such that sealing of said joint is effected after its assembly by relative thermal expansion of said first and second joint means.

The property of materials whereby their length increases with increasing temperature — to varying extents in different materials — is thus intentionally utilised for increasing the pressure at the sealing surface.

A common feature of all embodiments of the invention is a non-sealing positive connection, for example of the bayonet and/or screwthread type, between the two parts of the joint, which connection is adapted to receive the pressures set up at a sealing surface by the thermal stresses.

The joints may be divided into two distinct groups, viz :

1. those consisting of materials having equal or substantially equal coefficients of thermal expansion ; and
2. those consisting of materials having different coefficients of thermal expansion.

In the former case, the dimensions of the two parts of the joint are such that at least one of the two parts to be connected must be heated or cooled before the actual connecting operation. As a result of temperature equalisation after assembly of the joint, the relative dimensions of the parts of the joint are changed, whereby a very effective sealing pressure is produced at the sealing surfaces. The release of such a connection can be facilitated by heating or cooling the corresponding parts, so that the surface pressure which impedes the release of the seal is reduced. As long as the individual parts of the connection are at substantially the same temperature during operation, which may be ensured by appropriate constructional steps, the joint will retain its fluid-

tightness regardless of momentary differences in temperature.

Alternatively, or in addition, the desired thermal sealing can be obtained by the use of appropriate materials having different coefficients of thermal expansion. In this case, thermal pre-treatment i.e. heating or cooling can be omitted if the joint has to reach its maximum fluid-tightness only at increased or reduced operating temperatures. The resulting joint can readily be released at normal temperature, but can be released at operating temperature only by appropriate artificial cooling or heating of one of the component parts of the joint. It will therefore be desirable to construct the component parts of the joint so that heating or cooling means may be brought into operation in respect of one or both component members, for example by the introduction of electrical heating means or gas burners or by providing one or more conduits, e.g. channels or bores, in one or both parts through which a heating or cooling medium can be passed.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings in which Figures 1 to 12 are sectional views of releasable fluid-tight joints, and portions of such joints, in accordance with various embodiments of the invention.

Referring first to Figure 1, there is shown a closure member 2 which is screwed into a container 1 to engage positively therewith and which makes sealing contact therewith at an inclined sealing surface 3. That portion of the container 1 which lies in the vicinity of the connection is heated by means of a heating coil 12 before the closure member 2 is screwed into the container 1, and expands axially. The closure member 2 is thereafter screwed in until the sealing surfaces of the member 2 and of the container bear firmly against each other. As a result of the subsequent cooling of the container 1 the elongation thereof due to the said expansion is cancelled out, so that the closure member 2 is urged against the sealing seat in a manner such that a completely fluid-tight and pressure-proof closure of the container 1 is ensured. When the temperature of the container and closure member 2 are substantially the same, the closure member can be removed only with difficulty. In order to remove the closure member 2 it is thus desirable to cool the closure member 2, for example by means of cooling coils 11 provided therein, so that it contracts and the surface pressure on the sealing surfaces 3 is reduced.

If the member 2 consists of a material having a greater coefficient of thermal expansion than the container 1, a further increase of sealing pressure will occur at elevated operating temperatures.

Referring next to Figure 2, there is shown an embodiment in which the same thermal conditions as have been described in connection with the embodiment of Figure 1 are employed for closing and opening the container. However, in this embodiment the two parts 1 and 2 do not bear directly one against the other. The sealing is effected with the aid of a separate sealing ring 3′ which is pressed by the closure member 2 against the container 1.

It is advantageous in practice to replace the direct screwthreaded connection between the container 1 and member 2 by a retaining ring which is screwed into the container 1 and presses the member 2 against the sealing ring 3′. Rotational movement of the member 2 itself against the sealing ring 3′ during a closure or opening operation is thus avoided.

Figure 3 shows an embodiment in which a radially directed pressure, and not an axially directed pressure as in the embodiments of Figures 1 and 2, is produced by thermal loading. The closure member 2 is introduced into the container 1 (which has previously been heated so as to increase its internal diameter) and is held in positive engagement therewith with the aid of a suitably shaped locking ring 4. When the container 1 has cooled, sealing with respect to the member 2 is produced along surfaces 3″ by the reduction in the diameter of the container 1 due to the cooling. This embodiment is suitable for containers intended for use at elevated temperatures if the member 2 is composed of a material having a higher coefficient of thermal expansion than the container 1. In such a case, the sealing is produced by an increase in the external diameter of the member 2 relative to the container 1. For releasing the seal at elevated temperature, it is merely necessary for the member 2 to be artificially cooled.

Figure 4 shows an embodiment (showing two alternative forms of sealing) incorporating cooling and heating passages. Sealing is effected either by means of abutting inclined surfaces 3, as shown on the right hand side of the Figure, or by means of an interposed sealing ring 3′, as shown on the left hand side of the Figure. The parts subjected to thermal expansion have a length which is chosen in dependence upon, and project into the interior of the container to an extent which is chosen in dependence upon, the desired magnitude of the sealing force. In this case, a closure member 2, which is tightly connected to a sealing member 1 at the lower end thereof, is introduced into a container 5 until the sealing surface of the member 1 bears on the sealing surface of the

container 5. The part 2 is composed of a material which has a greater coefficient of thermal expansion than the material of the part 1. A screwthreaded sleeve 7 is screwed over the member 2 until a locking member 4 can be brought into positive engagement with the container 5. The screwthreaded sleeve 7 is then screwed out again until a sufficient pressure is exerted at the sealing surfaces 3 or 3′. When the container reaches an elevated temperature, the member 2 expands and thus increases the sealing pressure at 3 or 3′, the member 4 serving as an abutment. If sealing is to be effected before the parts of the joint are heated as a result of the container being used, a heating medium may be flushed through channels 10 and 11 so as to follow the track indicated in the Figure by broken lines, until the desired operating temperature has been reached. The necessary elongation of the member 2 is thus artificially meaintained until the internal heating of the container is sufficient to produce and to maintain the necessary sealing pressure.

Since there is an annular space between the members 1 and 2, it is also possible (where the container 1 is not to be heated to an elevated temperature), when materials having the same or substantially the same coefficients of thermal expansion are employed for these parts, to heat and thus to expand the member 1 before it is introduced into the container. Thus, on cooling to the operating temperature, the same effect can be obtained. In this case release of the closure can be effected by cooling the interior of the sealing member 2, which is thus shortened and relieves the sealing pressure at the surfaces 3 or 3′.

Referring now to Figure 5 there is shown an embodiment in which a radial sealing pressure is exerted by inclined surfaces on members 2 and 1′ against an interposed sealing ring which is thereby pressed against the wall of the container 5. Passages 10, 11 and 12 for cooling or heating media are provided and a locking member 4 of the bayonet joint type forms an abutment for the member 1′. The inner member 2 is drawn upwards by means of a screwthreaded sleeve 7 until a moderate sealing action is produced by means of the sealing ring 3. Thermal sealing is effected in the manner already described with reference to Figure 4. Walls 9 indicated by dash-dotted lines serve to guide the heating or cooling medium, the path of which is shown in chain lines. If the parts of the arrangement are composed of like materials, the member 1′, for example, is cooled before being introduced and expands on temperature equalisation with the remaining component parts and thereby produces a radial sealing pressure against the sealing ring 3. For release of the connection, the inner member 2 is heated to a temperature greater than that of the other parts of the joint so that it expands and relieves the sealing ring 3 of the additional pressure whereby the locking member 4 can be opened after slackening of the screwthreaded sleeve 7.

All the above-described embodiments have been employed in the sealing of vessels. However, they may also be employed to seal, for example, the ends of guide tubes for the fuel elements of a nuclear reactor.

Figures 6 and 7 show embodiments of sealing rings consisting of metal or other materials, which rings may serve in the same way as the sealing ring 3 of Figure 5 to seal the component parts of the connection.

Further examples of such sealing rings are shown in Figures 8 and 9. In these examples a sealing ring $3b$ is formed as a double cup spring. It is possible by adjusting the angle between the two surfaces in various ways to pre-set the pressure transmission ratio. In Figure 8 a part $2a$ is heated, and thus expanded before being screwed on the part $1a$. The sealing pressure produced by the screwing-in alone is further substantially increased by the subsequent cooling due to the temperature equalization, and thus effects the actual pressure-proof sealing of the cavity concerned. If the part $2a$ is composed of a material having a lower coefficient of thermal expansion than the part $1a$, complete sealing is effected by the heating of the vessel concerned during operation.

Figure 9 shows a similar closure means to that of Figure 2. A sealing ring $3b$ in the form of a double cup spring is welded or soldered at one end to a part $2a$ so that the sealing ring operates only upon one surface. The embodiment of Figure 9 may be modified to include sealing surfaces such as are shown in Figure 10.

Referring next to Figure 11, a sealing element 8 in the form of a double cup spring is joined at one end to a part $2a$, so that only sealing with respect to the part $1a$ need be effected. The part $2a$ is releasably connected to the part $1a$ at its lower end by means of a form of bayonet joint. The sealing member is initially tensioned with the aid of the nut 6. The operative part of the sealing element 8 is disposed between the bearing rings 16, 16′. The sealing pressure is increased as in the above described embodiments by partial pre-heating or, in the case of materials having different coefficients of thermal expansion, by the operative heating.

The above-described embodiments enable very high sealing pressures to be obtained in a simple manner. Such pressures may sometimes be so high that the parts employed are plastically deformed. However,

since re-adjustment of the sealing seat by means of screwthreaded sleeves and the like is always possible, such deformation can generally be disregarded. Nevertheless, cases may arise in which the pressure exerted should not exceed a certain value. Figure 12 shows an embodiment in which the pressure exerted can be adjusted by means of a pressure limiting spring 15. In the embodiment shown in Figure 12, a part of the joint is arranged to be freely expansible so as not to increase the sealing pressure, this being an arrangement which may often be necessary for constructional and technological reasons. There is provided a limiting member 14 which is adjustably connected by means of a screwthread to a locking member 4. The locking member 4 is in engagement with a sealing element 8 in the form of a double cup spring. On contraction of a part 2*a* after it has been heated and then assembled in a part 1*a*, the pressure thus set up acts on the sealing element 8 and on the freely expansible part of the joint which takes the form of a pressure limiting spring 15. The member 4 at the same time prevents excessive deformation of the spring 8. The locking member 4 is releasably but positively connected to the part 1*a* by a form of bayonet joint, so that the position of the part 2*a* is fixed.

The thermal operation of the arrangement is as described above in connection with other embodiments of the invention. The part 2*a* may, for example, be formed with passages for a cooling or heating medium.

The part 2*a* can be released in the hot operative condition if it is briefly cooled. Thus this may be of great importance, for example, in connection with the operation of a nuclear reactor employing such a joint. In particular, the connections of the guide tubes for the fuel elements of a reactor vessel can be constructed as in this embodiment. (In this way, the separation of two media, which may be different, can be effected for slowing down the neutrons and for cooling).

The closure means described above may be modified in various ways and may be employed for closing openings, for example of rectangular cross-sectional shape. In addition to closures, tube connections and bushings in containers and walls, and similar structures may also be constructed in the manner of the joints described with reference to the drawings.

WHAT WE CLAIM IS:—

1. A releasable fluid-tight joint comprising co-operating first and second joint means, each joint means having a sealing portion adapted to co-operate with the sealing portion of the other joint means and remote from said sealing portion a connecting portion adapted to engage positively with the connecting portion of the other joint means, said joint means being made from materials and having dimensions such that sealing of said joint is effected after its assembly by relative thermal expansion of said first and second joint means.

2. A releasable fluid-tight joint as claimed in Claim 1, wherein at least one of the two joint means is constructed in a manner such that cooling or heating means may be applied thereto in order to enable the pressure exerted between said sealing portions to be reduced when desired.

3. A releasable fluid-tight joint as claimed in Claim 2, wherein at least one of the two joint means is provided with one or more conduits for conveying a cooling or heating medium therethrough.

4. A releasable fluid-tight joint as claimed in Claim 1, 2 or 3, wherein a resilient sealing member is arranged to be disposed between the sealing portions of said first and second joint means.

5. A releasable fluid-tight joint as claimed in Claim 4, wherein said resilient sealing member is fixedly connected in a fluid-tight manner to one of said sealing portions.

6. A releasable fluid-tight joint, substantially as hereinbefore described with reference to the accompanying drawings.

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957,720 COMPLETE SPECIFICATION
3 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

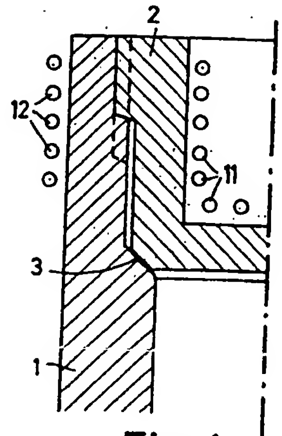

Fig. 1

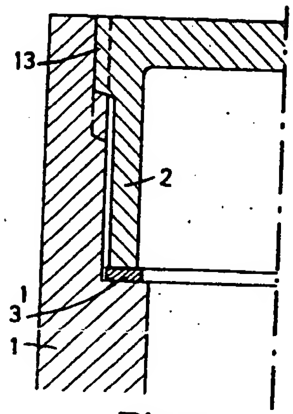

Fig. 2

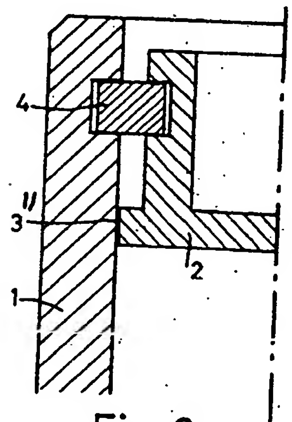

Fig. 3

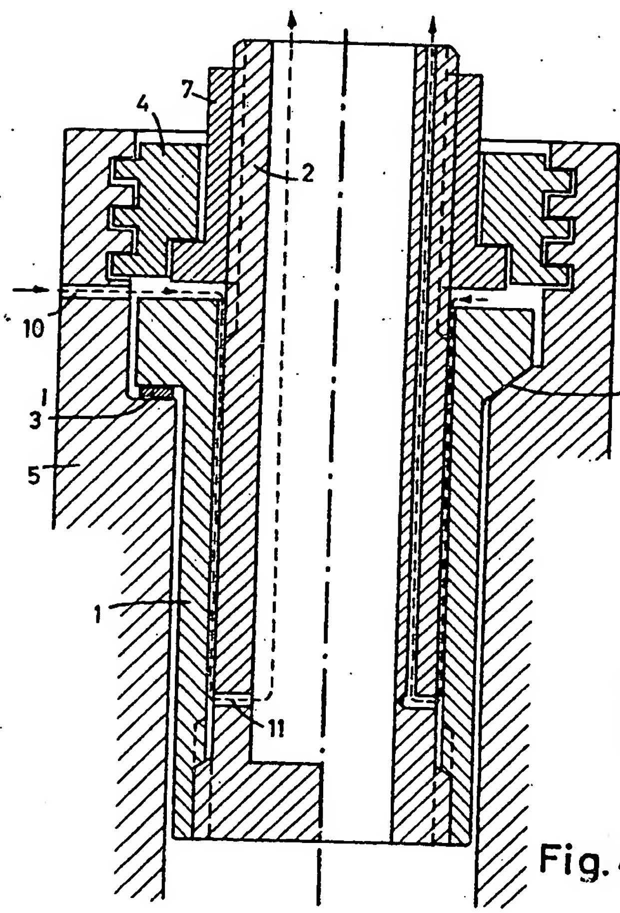

Fig. 4

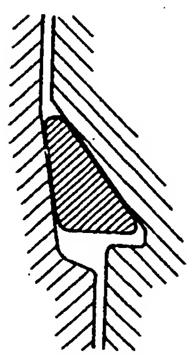
Fig. 6

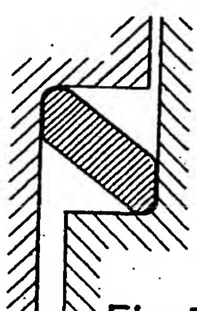
Fig. 7

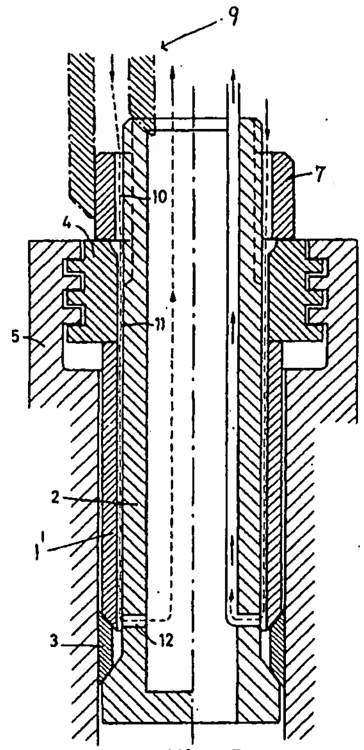

Fig. 5

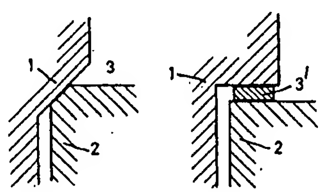

Fig. 10

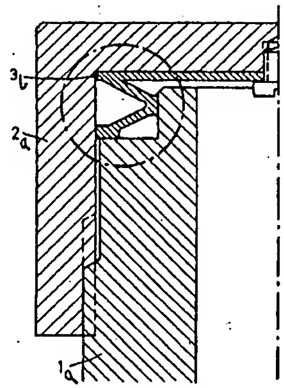

Fig. 8

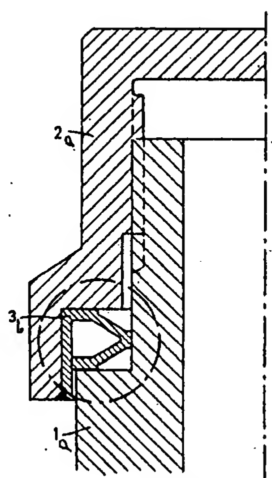

Fig. 9

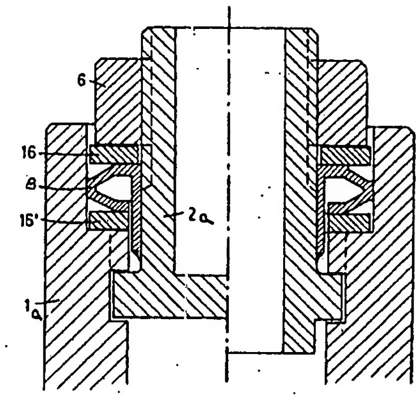

Fig. 11

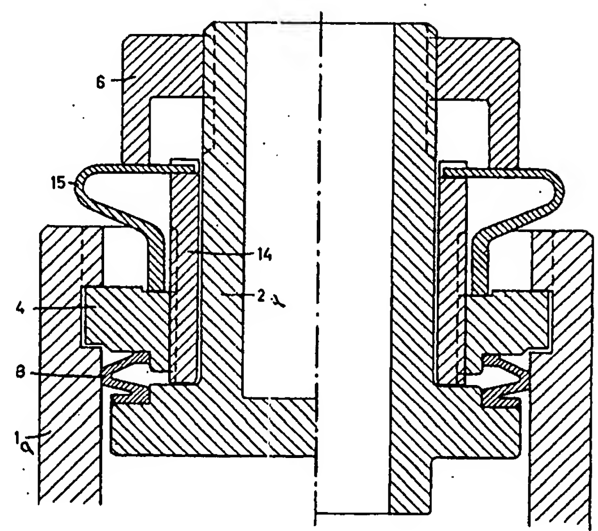

Fig. 12